

Title

TRUSS MANUFACTURING METHOD AND SYSTEM

Technical Field of the Invention

[1001] The present invention generally relates to methods and systems for making trusses. In particular, it relates to a method and system for making trusses out of metal members without the need for using an alignment jig.

Background of the Invention

[1002] Metal trusses are used for both commercial and residential structures. They are typically formed either from structural stud members or a combination of structural stud, non-structural stud and track members. Structural studs have cross-sectional profiles that provide them with structural stability; tracks generally have "U" shaped profiles that allow them to receive stud members fixed in a conventional, perpendicular configuration for making frame sections; and non-structural studs have profiles that give them reduced structural support but make them amenable for other functions such as receiving other studs.

[1003] Different design types such as frame and back-to-back trusses are commonly used for roofing and floor applications. Frame trusses are similar to wall frames except that they have a roof-shaped profile rather than a rectangular wall shape. They have upper and lower tracks with parallel, vertically oriented stud members sandwiched between the tracks to provide structural support for the roof material. They are relatively easy to make because they employ conventional wall framing methods, which have been honed over the years and allow for the manufacture of many different frames in an efficient manner. For example, in one known method, a roll-forming machine automatically produces the entire set of tracks and studs required for one or more trusses in a relatively short amount of time. (Roll forming machines are used to make both studs and tracks from rolls of light-gauge steel (e.g., 24 to 14 gauge) by bending and cutting the metal coil into studs and/or tracks with appropriate lengths

and channel dimensions.) The tracks have pre-punched fastener holes, spaced apart on their flanges, for receiving the studs, which have corresponding pre-punched holes. This allows the frame assemblers to quickly position and fasten the studs to the tracks by using the fastener holes to not only fasten the studs to the tracks with screws or rivets, but also to align the studs within the track. One drawback, however, is that frame trusses are limited in their span and load capabilities and are less efficient in terms of the amount of stud material needed within each truss for supporting a given load.

[1004] Back-to-back trusses, on the other hand, are generally better in terms of their load carrying capability and they can span much larger openings. This is so because they use structural studs, such as “C” channel or other structural studs, connected back-to-back without the use of tracks and because they use triangulated web members, rather than just vertically oriented studs, which provide added stability and support for the same amount of stud material. Unfortunately, however, such back-to-back trusses are more difficult to design and assemble because of their more complicated web member configurations. As with frame and other metal trusses, roll-form machines can be used to efficiently generate the stud members used for the back-to-back trusses, but assembling the members into the trusses is more difficult, especially when different truss types are being assembled. For each truss type, a jig (or pattern) is typically fabricated based on an assembly drawing. The jig, which is normally made from heavier steel, is used for aligning truss members as a truss is being assembled, one truss at a time. It holds the members in place while an assembler inserts self-drilling screws at each node where members connect with each other. This can be efficient when a large number of trusses of a given design are made. Unfortunately, when trusses of many different designs are to be made, this method breaks down because an excessive amount of time is required for creating a separate jig for each different truss design.

[1005] Accordingly, what is needed is an improved method for making trusses.

Summary of the Invention

[1006] Methods and systems are provided for making one or more structural stud trusses without the need for using a jig when the truss is assembled. In one embodiment, data identifying a plurality of structural stud members for making the truss is generated. The data includes data for each stud including physical stud parameters and one or more locations for an alignment guide where another member is to connect with it. A roll forming machine is controlled with the generated data to produce the plurality of stud members whereby the roll forming machine applies one or more alignment guides onto each member based on locations identified in the generated data. Finally, after all or some of the stud members are formed, the members are assembled to form the truss using the alignment guides to align connecting members with each other in order to fasten them together.

[1007] A kit is also provided for making a truss. In one embodiment, such a kit includes one or more chord members and one or more web members. The one or more chord members are formed using structural studs that each have a web portion. Similarly, the one or more web members are formed using structural studs that each have a web portion. The chord and web members also each have an alignment guide located on their web portions where they are to connect with another chord or web member thereby enabling the truss to be assembled without the need for a jig.

[1008] The foregoing has outlined rather broadly the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter. It should be appreciated by those skilled in the art that the conception and specific embodiment disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes as the present invention. It should also be realized by those skilled in the art that such equivalent

constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

Brief Description of the Drawings

[1009] For a more complete understanding of the present invention, and the advantages thereof, the following description is made with reference to the accompanying drawings, in which:

[1010] FIG. 1A is a side profile view of a conventional roof truss made in accordance with an embodiment of the present invention.

[1011] FIG. 1B is an end profile view of a CEE channel stud member.

[1012] FIG. 1C is an enlarged view of area "A" from FIG. 1A.

[1013] FIG. 2 shows a tag portion of a truss member made according to one embodiment of the present invention.

[1014] FIG. 3 is an exploded view of a connection between connecting truss members in accordance with an embodiment of the present invention.

[1015] FIG. 4 is a block diagram of a system for making trusses according to one embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[1016] With reference to Figures 1A-1C, an exemplary roofing truss 100 made in accordance with an embodiment of the present invention is shown. Truss 100 is a conventional roof truss made from roll-formed, structural stud members connected in a back-to-back configuration. It generally comprises a lower C-channel chord member 102, upper C-channel chord members 104, 106, and C-channel web members 101 to 117. The centerlines for each member are shown, along with connection nodes N1 to N18.

[1017] Truss 100 is a conventional roof truss formed, e.g., from light gauge (22 to 12 ga) steel stud members, but it is formed using techniques of the present invention and takes advantage of features available on conventional roll-forming machines. Namely, the machine is used not only to form and cut each truss member into its proper dimensions, but also, it applies an alignment guide at each part of a member that is connected to another member. An alignment guide, as used herein, can be anything such as a mark, feature, detent, recess, protrusion, hole, or the like that is used for aligning two or more members together at a particular desired location where they are to be connected to each other. The use of alignment guides makes it easier and more efficient to assemble stud members into a truss because it eliminates the need to use a jib for aligning and possibly securing the members as they are being fastened to each other. Instead, with the assistance of one or more persons, the alignment guides serve to accurately position the members relative to each other and with some alignment guides, secure them in place as they are being connected together, e.g., by a person with a self-driving screw gun. In one embodiment, the alignment guides are placed on the members at their connection nodes by a roll-forming machine used to form the members.

[1018] With continuing reference to Figure 1A, nodes N1 to N18, along with the centerlines for each member, are shown. A node occurs where two or more members are connected together and typically occurs at the intersection of the centerlines of the connecting members. However, nodes do not always occur at centerline intersections. For example, in some cases, nodes may be offset in an appropriate direction to place an alignment guide on a member when little space exists at the centerline intersection point. In other cases, as a matter of design choice, the nodes may simply be placed at overlapping portions of connecting members but not necessarily at the intersection of their centerlines. With truss 100, a node (such as N3) may be offset when a member has insufficient space at a connection

area as a result, e.g., of a relatively sharp angle between itself and the member to which it is being connected.

[1019] Figure 1B shows an end view of a “C” (or CEE) channel stud used for implementing the stud members in truss 100. A “C” stud is a structural stud typically formed from bending a metal strip with a roll forming machine to give it its web, flange, and lip portions, as shown in the drawing. The lip portions give the studs their added structural support quality in contrast with tracks, which have negligible or no lips. Light gauge steel roll is typically used but other suitable materials could also be used for making the “C” studs used in these trusses. A conventional roll-forming machine, such as a Knudson KS-246A FRAMEMAKER™ roll forming machine, can be used for making “C” studs out of light gauge steel roll. A single roll forming machine can typically make all of the members needed for one or more trusses of a given design. They have components for cutting the members into different lengths and tools for bending the steel into studs having different desired channel dimensions. In fact, depending on the particular truss design, most trusses will have web and chord members with different lengths and channel dimensions. In one embodiment, the truss members are formed as C-channel studs having various lengths and fixed lip and flange dimensions of 0.5” and 1.625”, respectively but with web widths that can range from 2.5” to 12” in width. However, persons of ordinary skill will recognize that the specific dimensions for each member will depend on the particular truss design, as well possibly on the truss design software used for designing the truss and available materials for building the truss.

[1020] With reference to Figure 1C, in one embodiment, holes are used as alignment guides. Figure 1C shows an enlarged view of area “A” in truss 100 in Figure 1A. With this type of alignment guide, a hole is created (e.g., punched out) at each node so that a peg (or dowel) can be inserted into overlapping holes of connecting members to temporarily hold and

align them to one another as they are connected together with fasteners such as screws.

Depicted in Figure 1C are the fastener connections 122 and alignment guide holes 124, corresponding to nodes N7 and N8, for aligning and securing web members 109 and 111 to chord member 106 while connecting the members to each other with screws 122. In this embodiment, the pegs are used to temporarily hold connecting members in place while they are connected. Screws 122 actually fix them together for operation in the truss. Any suitable fasteners can be used for connecting them together. Fasteners can include but are not limited to rivets, screws, bolts, weld joints, spots or clinches and the like. In the depicted embodiment, self-driving, #10 screws for light-gauge steel are used. In the connections at nodes N7 and N8, four screws 122 are used. The total number for each connection, however, may vary depending upon the truss design. As addressed below, in one aspect of the present invention, the number of screws is indicated near the alignment hole to make it more convenient for the assembler.

[1021] In the depicted embodiment, holes (with the assistance of pegs or dowels) are used as the alignment guides. However, the present invention is certainly not limited to such guides. Any suitable guide such as an indentation, dimple, fastener, or the like could also be used. One advantage of holes, however, is that they can readily be applied at or near a node with conventional roll-forming machines that have tools for punching holes that are otherwise used, e.g., for wiring and piping.

[1022] Figure 2 shows an end portion of a C-channel, truss member 201 formed by a roll forming machine such as the one mentioned above. It includes an assembly tag 202 and alignment hole 204. With various embodiments of the present invention, assembly tags are used to assist assemblers in laying out the constituent truss members to form a truss as they are emitted from the roll forming machine. With the use of assembly tags and a general understanding of the particular truss design, one or more assemblers can quickly lay out the

truss members without the need of a jig or even an assembly drawing of the truss. The assembly tag 202 has a length identifier 206, truss identifier 208, member identity identifier 210, and screw count identifier 212. The length identifier 206 indicates the length of the member. In the depicted identifier 206, the value "8-2-8" is given. The first number, 8, is in feet, the second number, 2, inches, and the third number, 8, in sixteenths of inches.

Accordingly, the length identifier in this example indicates that this member is 8 feet and 2.5 inches. The truss identifier 208 identifies the truss for a given lot. In many applications, members for numerous trusses are made from a single roll forming machine on a single occasion, so this identifier (T1 in the figure) identifies the particular truss in the lot for which the member belongs. The member identity identifier 210 indicates the connection nodes (15-16 in the drawing) at either end of the member. That is, this identifier indicates that the member is to be located between the identified nodes (nodes 15 and 16 in this example). The screw count identifier 212 identifies the number of screws to be mounted proximal to the alignment hole (204) that is next to the tag.

[1023] With conventional roll-forming machines such as the one discussed above, assembly tags such as 202 in the depicted figure can be printed onto a member at a desired location as the member is being formed. Thus, with appropriate control (discussed in greater detail below), a conventional roll-forming machine can create truss members with assembly tags and alignment holes without the need for additional equipment. Moreover, it can do this in a timely manner to produce truss members that can be assembled more efficiently than with traditional methods such as jigs.

[1024] Figure 3 is an exploded view of a connection between connecting truss members 301, 303 in accordance with an embodiment of the present invention. The web and chord member 301, 303 are connected in a back-to-back configuration with the members' web portions adjacent to one another and their alignment holes 305 aligned with one another.

A dowel (or peg) 304 is inserted into the associated alignment holes 305 to secure members 301 and 303 while they are fastened together with self-driving screws 302. The “back-to-back” connection shown in this figure is applied to all web/chord member connections for the truss in Figure 1A, which makes it a back-to-back, C-channel truss. While a circular hole and peg cross-section are used for the depicted alignment guide, other suitable shapes and schemes could also be used within the teachings of the present invention. For example, a non-rotatable (e.g., square, triangle, oval) shape could be used. Such a non-rotatable shape allows for more precise member alignment, i.e., it allows for members to be positioned together at precise angles without the need for other members to be in place. An oval alignment hole is well-suited as such an alignment guide because it is non-rotatable and it can be applied with a conventional roll forming machine by punching several holes overlapping one another. (Of course, other desired shapes can readily be used simply by providing a roll forming machine with a punch or cutting tool capable of making the desired shape.) In some embodiments, matching guides can also be used to ensure that assemblers connect the proper members at their proper locations. Matching guides are unique (or reasonably unique) in shape or size for each different connection node. This prevents assemblers from making improper member connections.

[1025] Figure 4 shows a system 400 for making trusses according to one embodiment of the present invention. System 400 can be used to design trusses and automatically generate the members for forming the trusses. System 400 generally includes computer 405, interface module 410, roll-form machine controller 420, and roll-form machine 425. Computer 405 is used to receive or generate truss design data based on information and instructions received from a user. It may generate drawings and other data describing a truss, and it also generates data identifying the lengths and channel dimensions for each member in the truss. The roll-form machine controller 420 controls the roll-form machine 425 to automatically generate the

truss members, and the interface module 410 processes the cut-list data to put it in a form that is readable by the machine controller 420 for it to control the roll-form machine 425 to make the truss members. It also includes data or instructions that cause appropriate alignment guides to be placed on the members.

[1026] The depicted computer 405 has a truss design program 407 that when executed by computer 405, can assist a designer in designing a truss for a particular need. In one embodiment, the truss design program is Keymark's KeyTruss™ software package that automates the analysis and design of back-to-back C-channel steel trusses. The use of such a program makes it easier to design a truss that conforms with standards defined by the AISI (American Iron and Steel Institute) with regard to cold forming steel framing. With the KeyTruss™ program, a user can input a truss profile specifying member lengths and positions, and the software determines the dimensions for each member based on available member dimensions as designated by the user. The program can also generate a drawing file (such as an AutoCad™ type DXF file), along with detailed material lists and cut sheets (e.g., .ROL file) for individual or multiple trusses.

[1027] In one embodiment, the interface module 410 uses data from one or more of these generated files to generate a control file for forming the constituent members and applying to them alignment guides for assembly of the trusses. It uses data from the truss design program 407 and outputs control files that are suitable for execution by the roll-form machine controller 420. The interface module comprises one or more software modules, patches, functions, routines, and/or programs running on computer 405, controller 420, a separate computer or processor, or a combination thereof. In the depicted embodiment, interface module 410, when executing, performs routine 412. Routine 412 includes the steps of receiving truss parameters from the design program at step 414, determining alignment guide locations for truss members at step 416, and generating control data for controlling the

roll forming machine to form the truss members at step 418. there are many suitable ways to perform the functions of routine 412. For example, they could be performed by a separate program running on computer 405 or on a separate processing machine. They could also be performed by a patch, plug-in or module designed to execute in cooperation with the truss design program 407.

[1028] Similarly, there are numerous suitable ways to perform the functional steps. In one embodiment, alignment guides are placed at nodes defined by member centerline intersections. From truss geometry data (which it can obtain from the truss design program or from another program if no truss design program is used), interface module 410 determines node locations for each truss member based on centerline intersections. It then generates (or modifies) a control file for execution by roll-form machine controller 420. In one embodiment, a patch, executing with the truss design program 407 to transform truss member cut list data (e.g., from a KeyMark™ “.rol” format) into a suitable machine controller format is enhanced (or augmented with another patch) to include this node location data to cause the machine to also punch an alignment guide hole in the nodes on the truss members. In another embodiment, further functionality is included that alters node locations when it is determined that the node is too close to the edge of a member. Interface module 410 may also generate controller file data for causing a an assembly tag such as the one discussed above to be applied to each member.

[1029] The roll-form machine controller 420 and roll-form machine 425 operate in cooperation with one another to automatically generate the members for a truss. Any suitable combination of conventional devices can be used to implement these components. In one embodiment, the roll-form machine is a Knudson KS-246A FRAMEMAKER™ roll forming machine, and the controller 420 is an AMST™ XL200 Series Controller, which is designed specifically for controlling forming machines such as the Knudson roll-forming machine.

With this controller, a command file in an appropriate format (e.g., “.del” format) can be uploaded into the controller and used to control operation of the roll-forming machine 425. It should be recognized, however, that numerous other combinations of compatible controllers and roll-forming (or other stud manufacturing) machines could also be used.

[1030] With system 400, many trusses of the same or different designs can be manufactured in a reasonable amount of time. The truss members can be assembled almost as fast as they are produced by the roll-form machine. With the elimination of the need for an alignment jig, not only can many different truss designs be assembled in a small amount of time, but also, assembly can occur at a construction site, as well as in a shop or factory.

[1031] The present invention and its advantages have been described in detail, but it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification.

[1032] For example, while trusses using C-channel stud members were primarily discussed, other suitable stud designs (including proprietary designs) could certainly be used in accordance with the teachings of the present invention. Similarly, the trusses of the present invention are not limited to just roof trusses but could include trusses for any application including floor trusses. Likewise, while back-to-back structural stud trusses were primarily addressed, the manufacture of other truss design types could be enhanced with the principles set forth herein. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments

described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

We claim as follows: